

TMDL Development

- **Model Development** ⚙️
- **Problem Assessment** ⚙️
- **TMDL** 📁

Model Name

- **River**
 - **Basin**
 - **Model developed in EPA Region**
 - **10**
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- **RBM10 is written in Fortran code and can be adapted to simulate any large scale river**

CONFERENCES
RESEARCHERS

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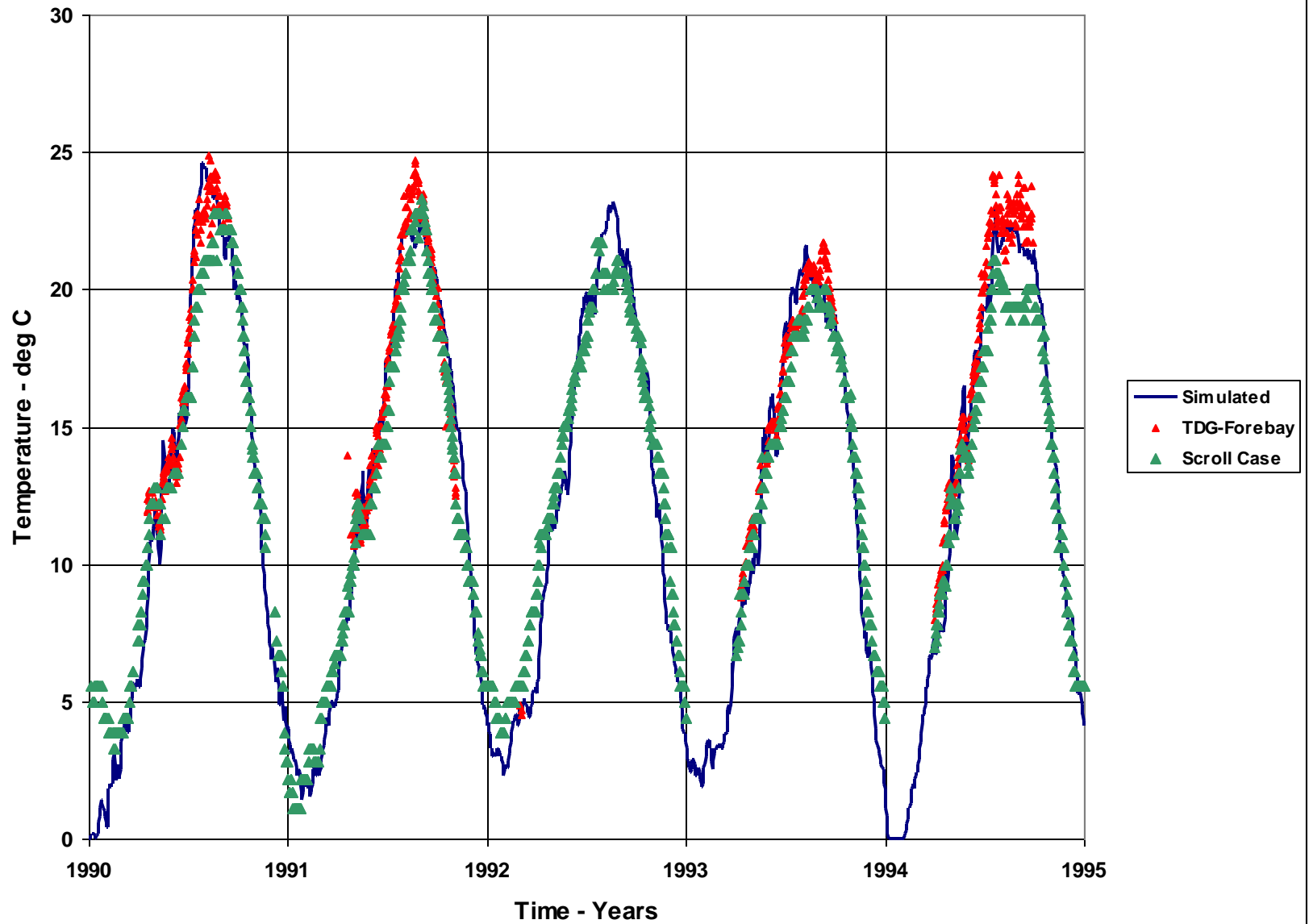
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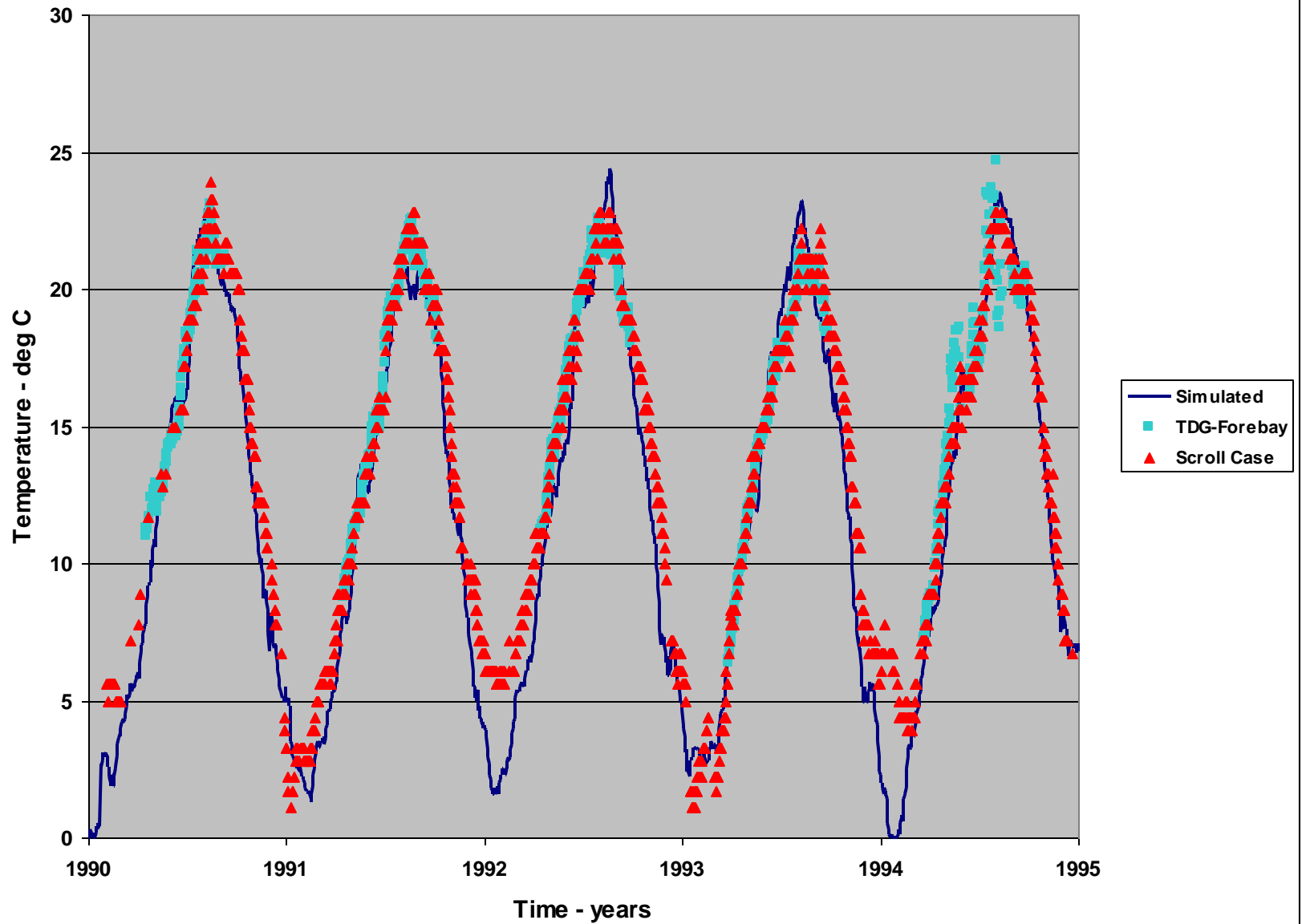
Why Do We Need Process Model?

- **We need to estimate temperatures under un-impounded conditions for which measurement data is scarce**
- **We have conflicting measurements**
- **We do not have measurements at all river locations of interest**
- **We need to estimate influence of different sources**

Simulated and Observed Water Temperatures at Ice Harbor



Simulated and Observed at Bonneville Dam



**Figure D-6. Regression of observed on simulated at Ice Harbor
Dam 1990-1995**

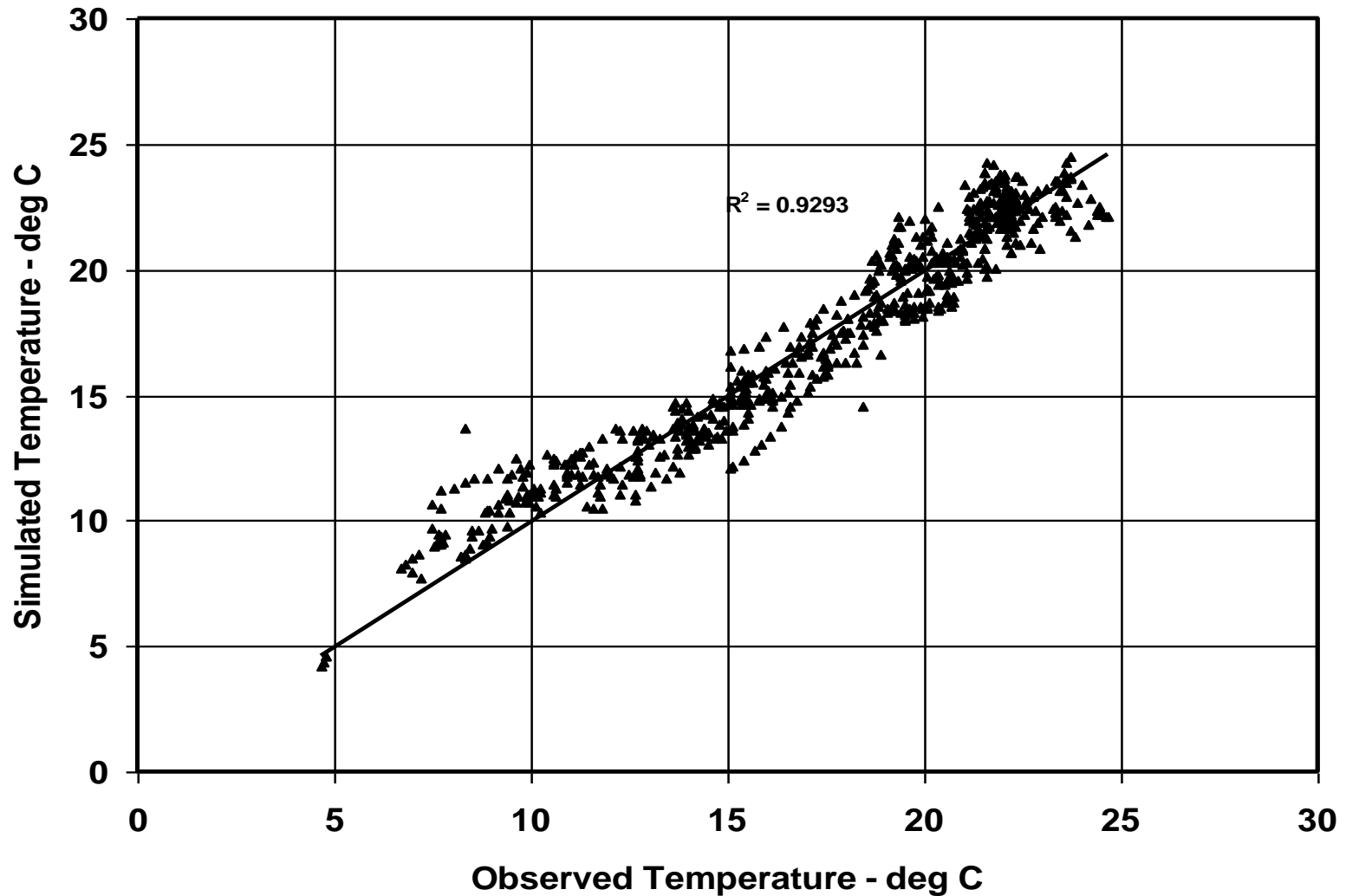
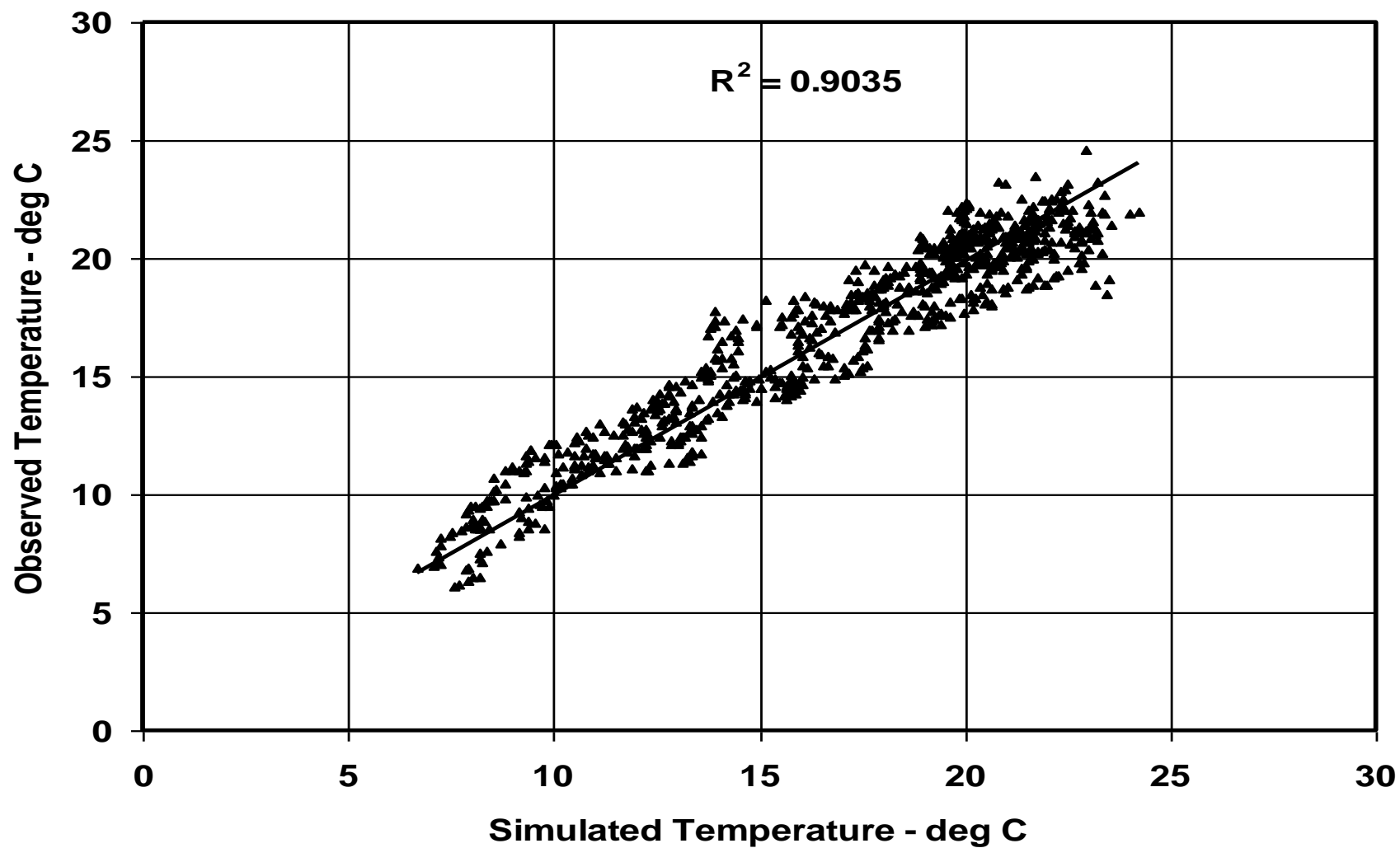


Figure D-5. Regression of observed on simulated at Bonneville Dam 1990-1995.



RBM10 Results for 1990-1994

<i>Location</i>	<i>Mean Difference (Obs-Sim)</i>	<i>Standard Deviation</i>
<i>Snake River @Ice Harbor</i>	0.05 deg C	1.2
<i>Columbia River @Bonneville</i>	0.04 deg C	1.3

Error Estimates from Other Studies

- **RISLEY (1997) - Tualatin River**
Max Mean Difference = 3 Deg C
Mostly < 1 Deg C
- **BATTELLE-MASS1 (2001) - Columbia River**
RMS Error = 0.59 - 1.52 Deg C
- **HDR/PORTLAND STATE/IPC (1999) - Snake River**
AME = 0.6-2.3 Deg C (1992 data)
AME = 0.5-2.0 Deg C (1995 data)
- **CHEN (1996) - Grande Ronde River**
Error = -2.20 - 8.28 Deg C (Summer Max)
Error = -1.21 - 7.69 Deg C (Avg 7-day Max)

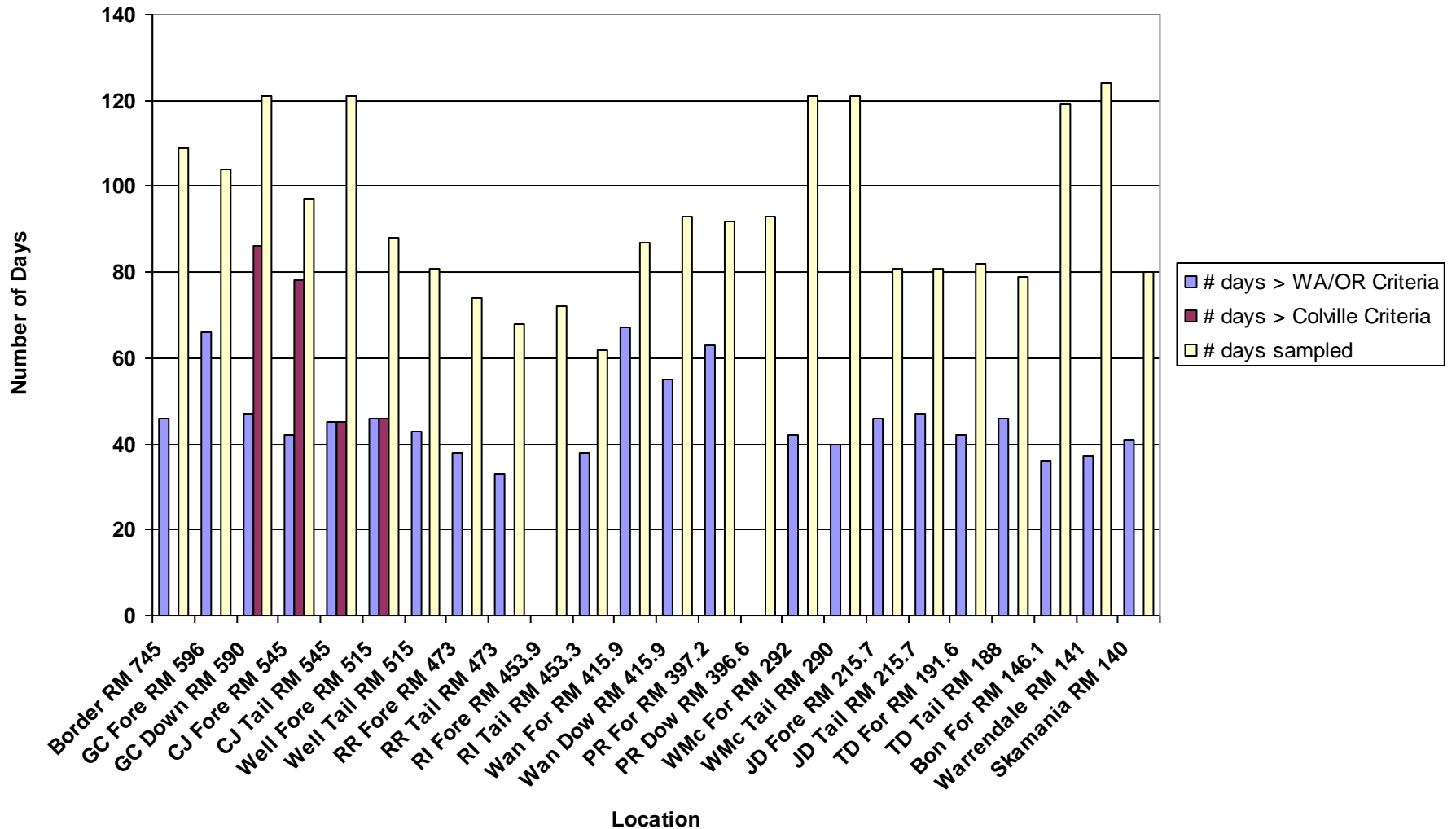
Problem Assessment

- Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

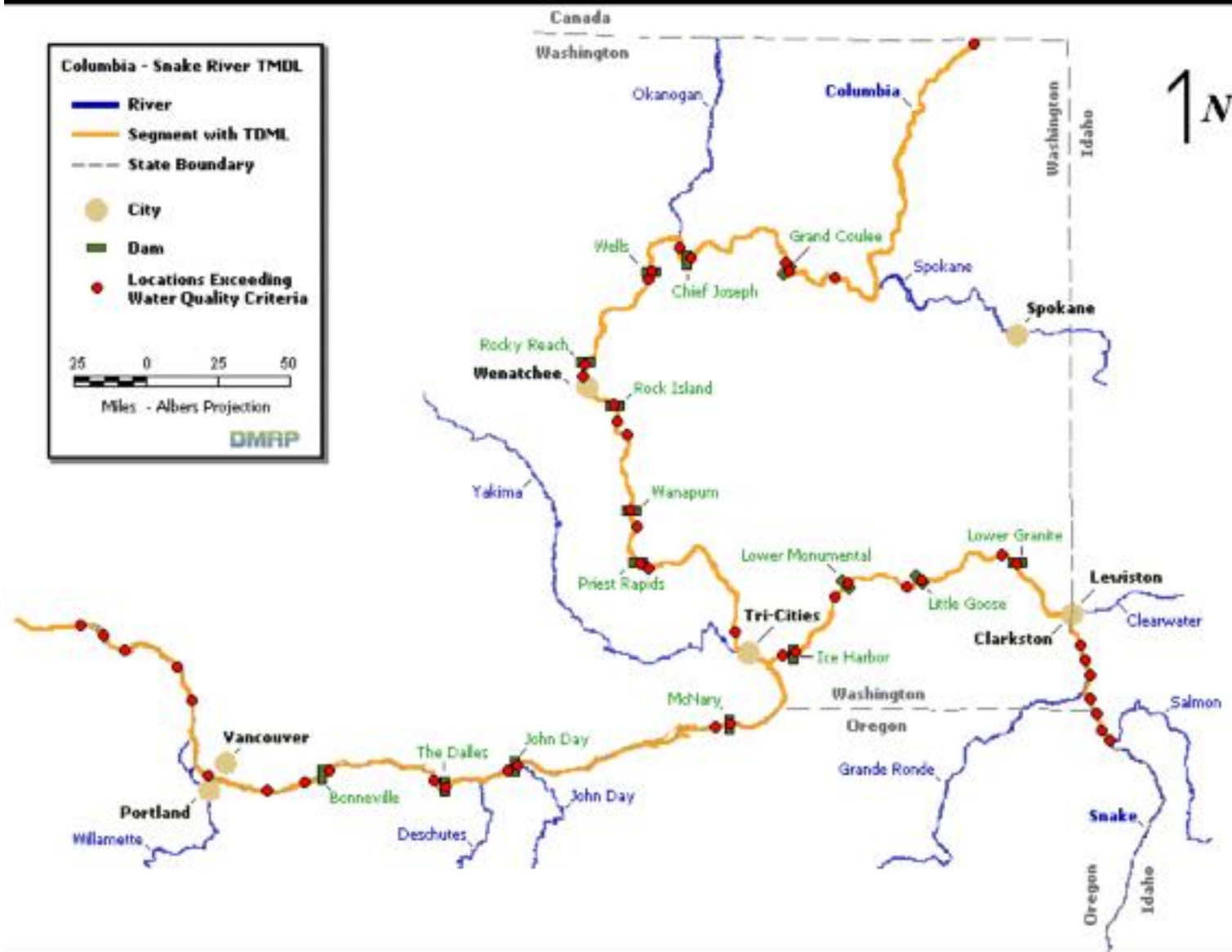
Problem Assessment

- 1) Does temperature exceed the Water Quality Criteria?
- 2) Does temperature exceed the Water Quality Criteria due to human activities?

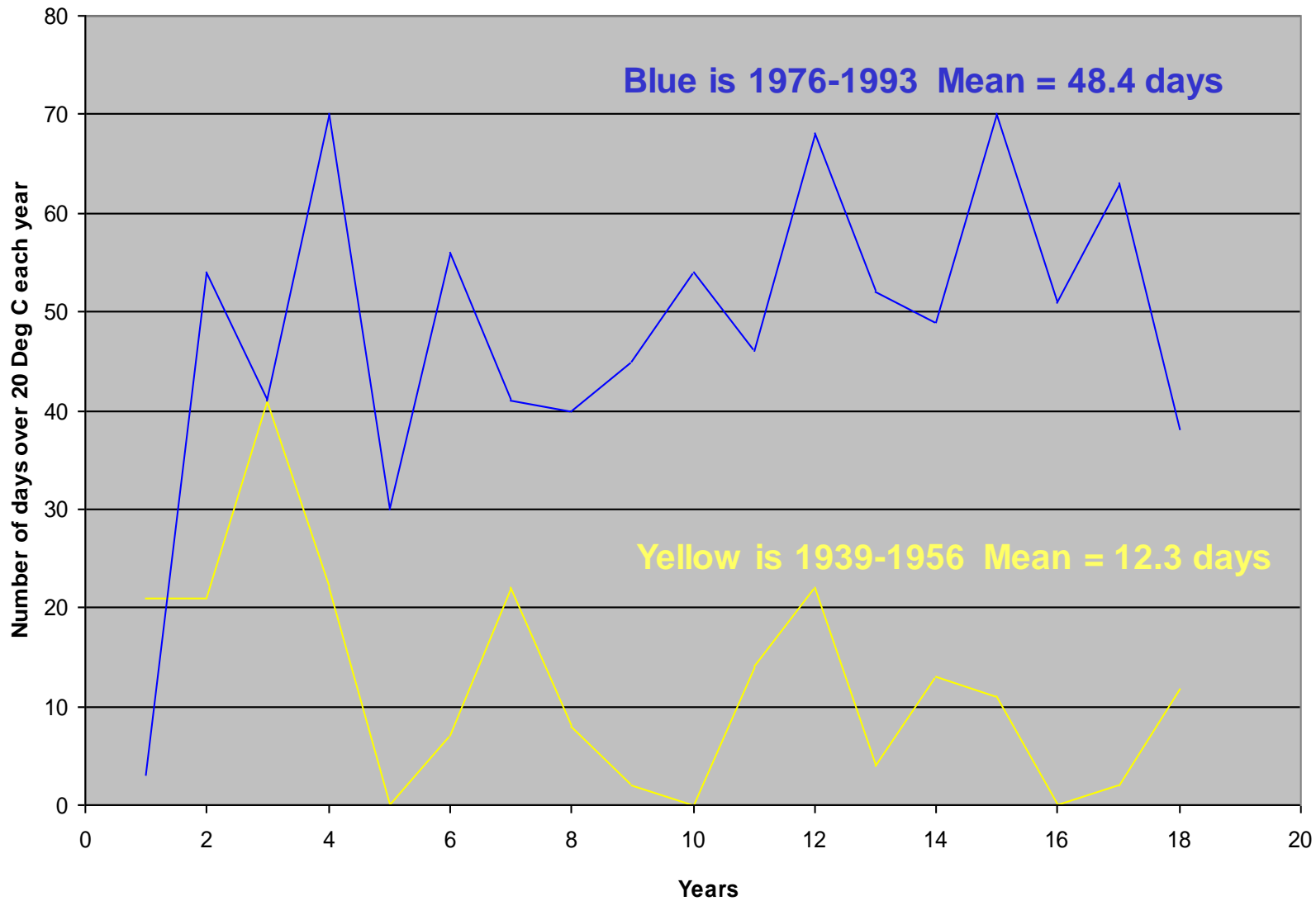
July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



Geographic Scope

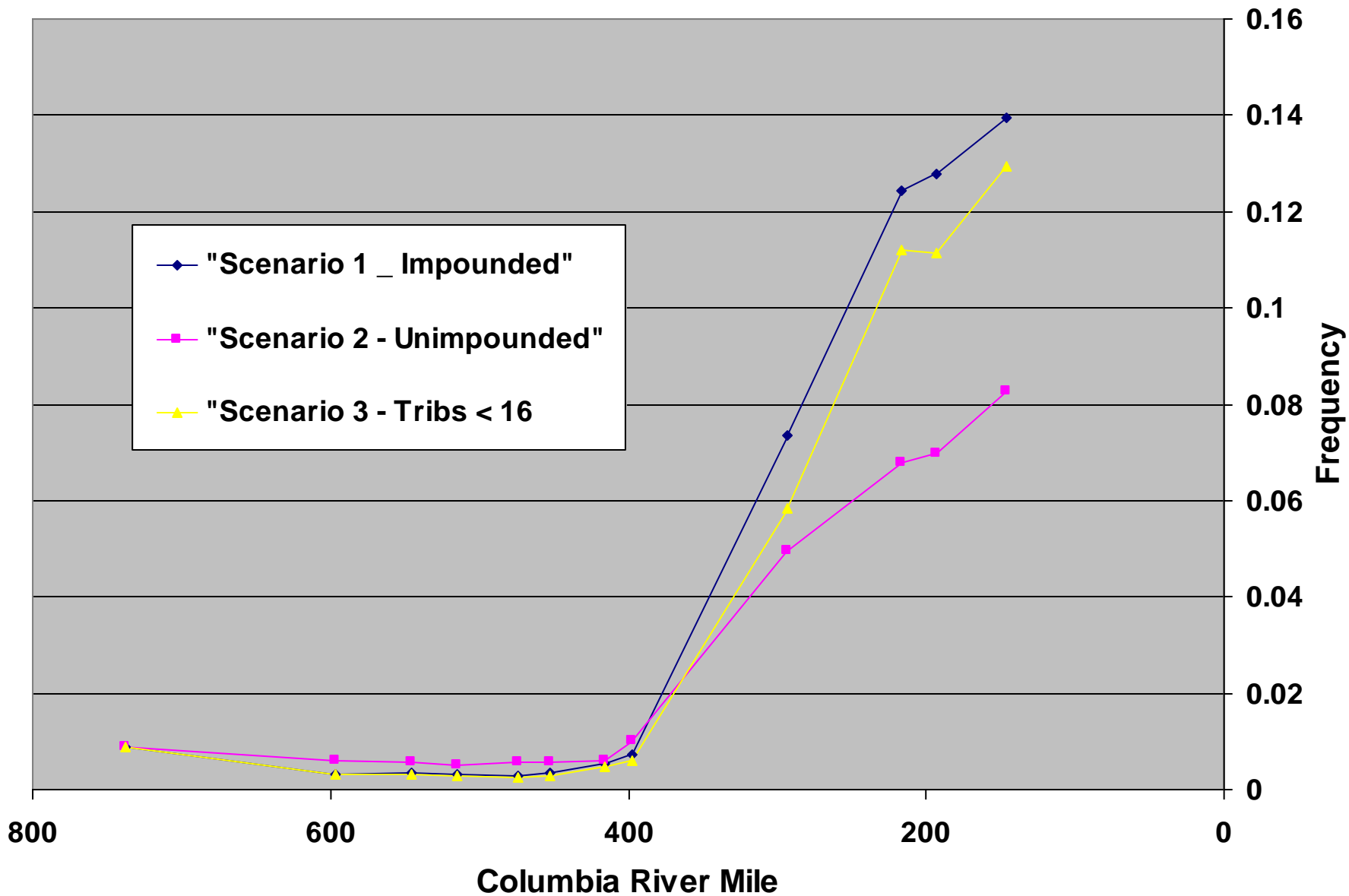


**Number of Days that Exceed 20 Deg C at Bonneville Dam: Comparison of the two periods
1939-1956 and 1976-1993**

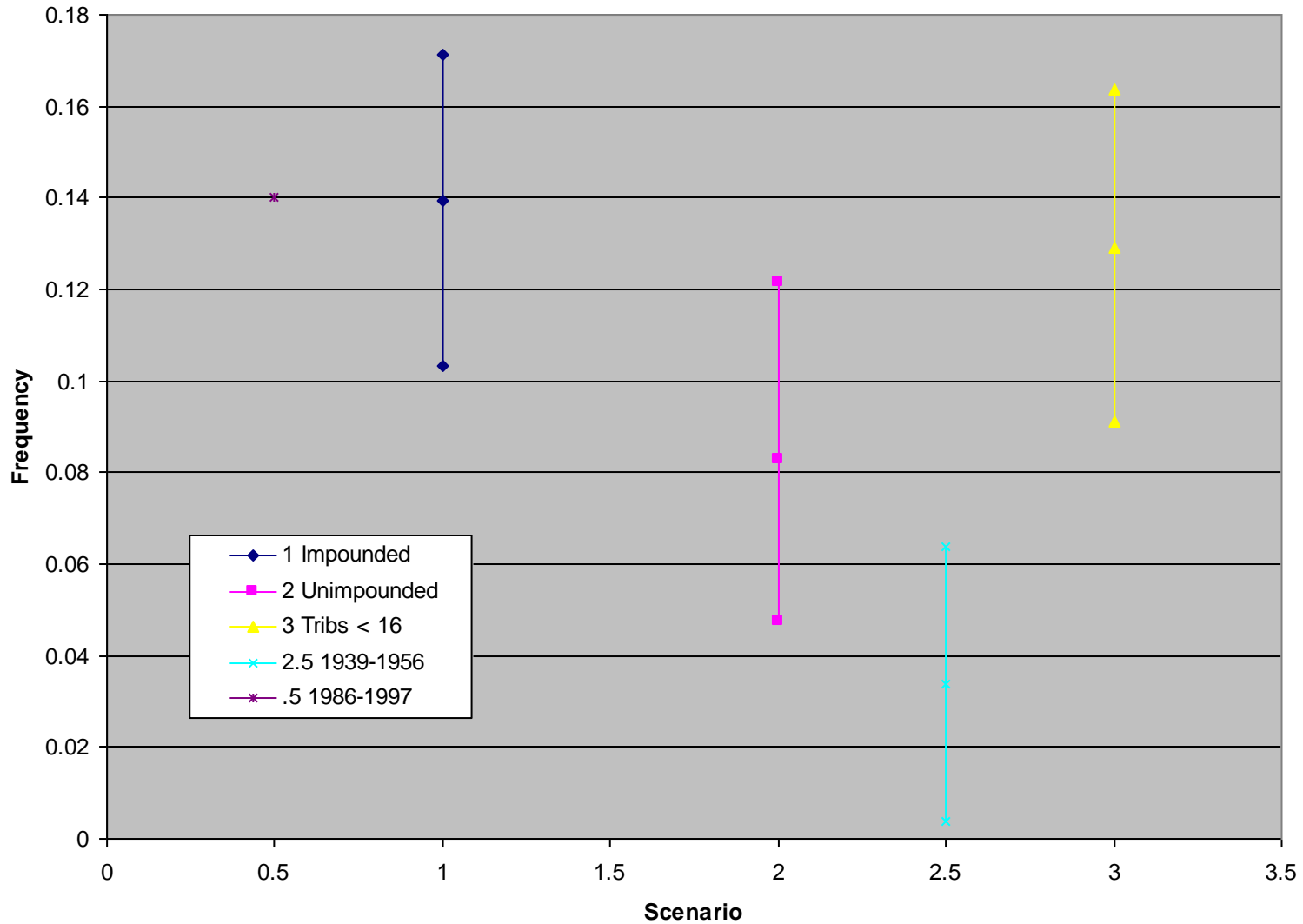


Problem Assessment

- Principle cause for the warming trend in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.



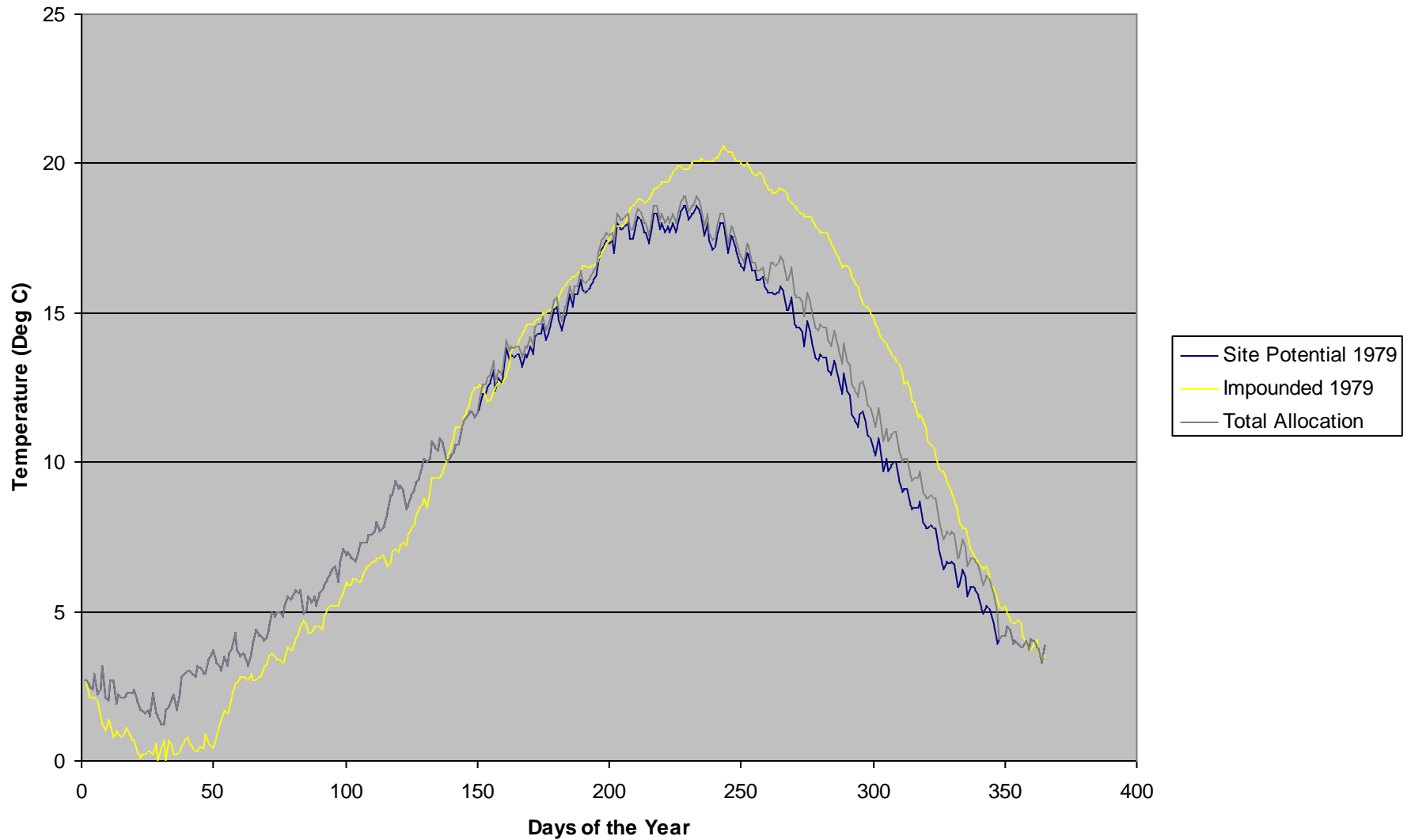
Frequency of Exceedance of 20 deg C at Bonneville Dam: Simulations and Observations



TMDL

- The target temperature for the TMDL is site potential (SP) temperature + small increment allowed by the WQS.
- (eg $SP + 0.14^{\circ}\text{C}$ when $SP > 20^{\circ}\text{C}$ and $SP + 1.1$ when $SP < 20^{\circ}\text{C}$ in the lower Columbia.)

Grand Coulee - allocations based on median site potential design year



Grand Coulee - median and 95th percentile design years

